City of Fairfax
Watershed Management Plan

Public Meeting No. 2

March 27, 2003

The Louis Berger Group, Inc.

Outline

- Recap from Meeting 1
- Model Development
- Model Results
- Discussion

Watershed Management Planning

Is an effort to coordinate and integrate the programs, tools, resources, and needs of multiple stakeholder groups within a watershed to conserve, maintain, protect, and restore the habitat and water quality of a watershed.

Problem: Stormwater Runoff

- Changes in land use due to urbanization leads to:
  - Higher runoff volumes
  - Higher Flow rates
  - Shorter lag time

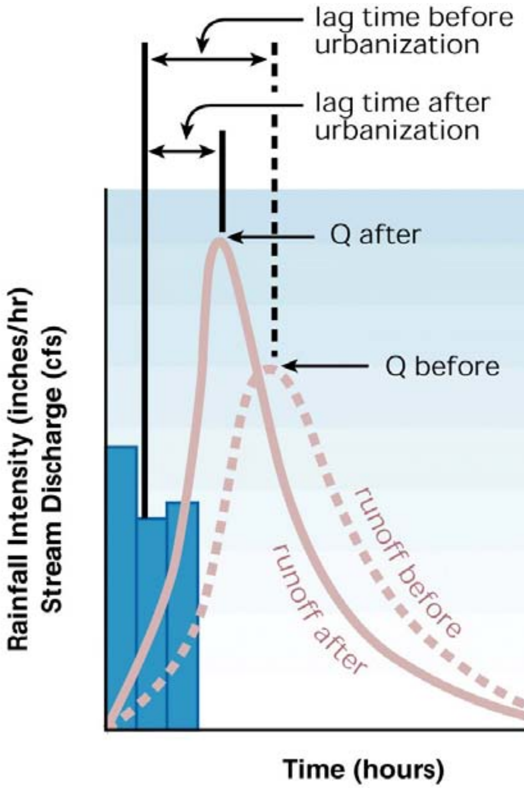
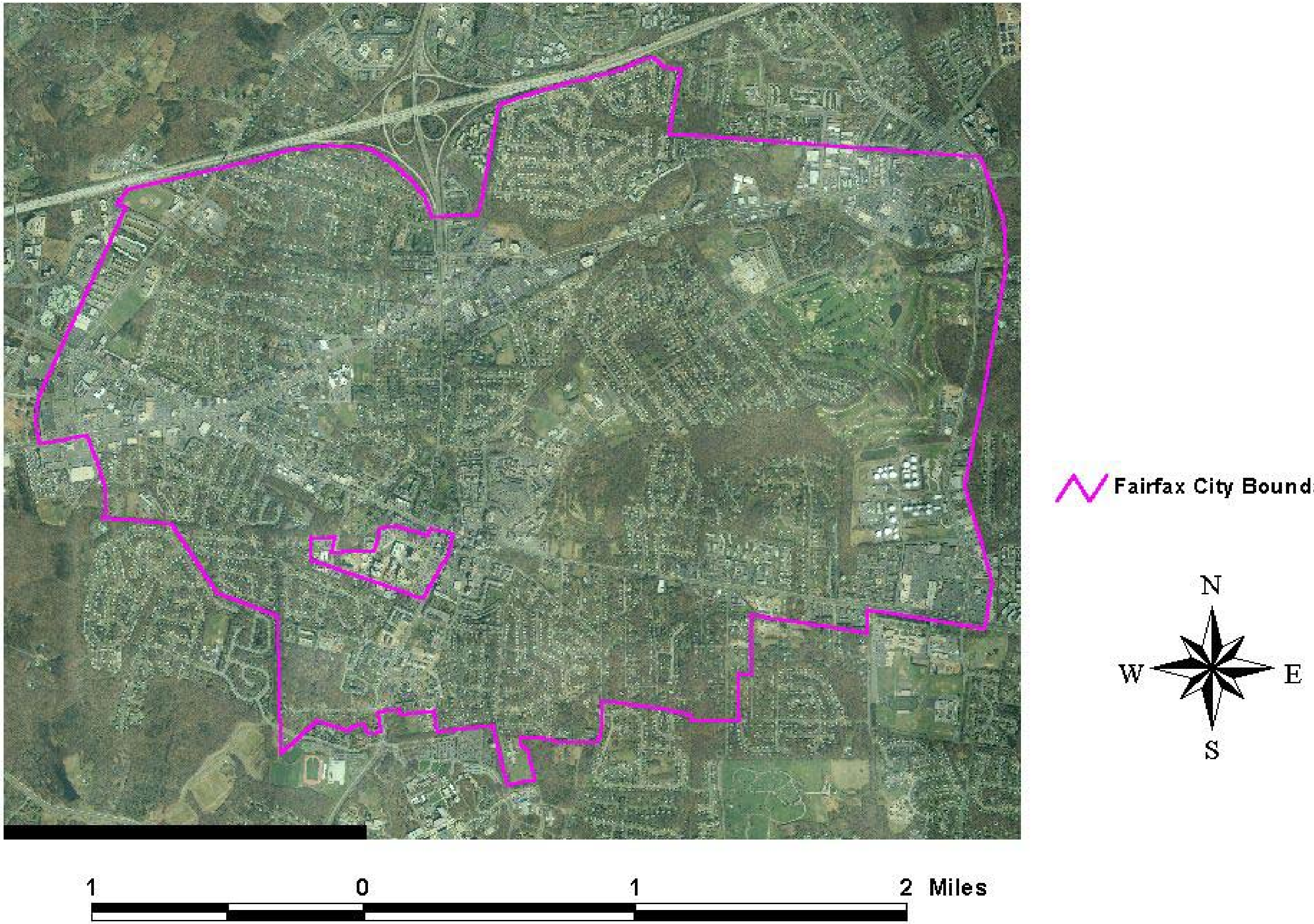


Fig. 1.15 -- A comparison of hydrographs before and after urbanization. The discharge curve is higher and steeper for urban streams than for natural streams.
In Stream Corridor Restoration: Principles, Processes, and Practices (10/98).
Interagency Stream Restoration Working Group (15 federal agencies)(FISRWG).

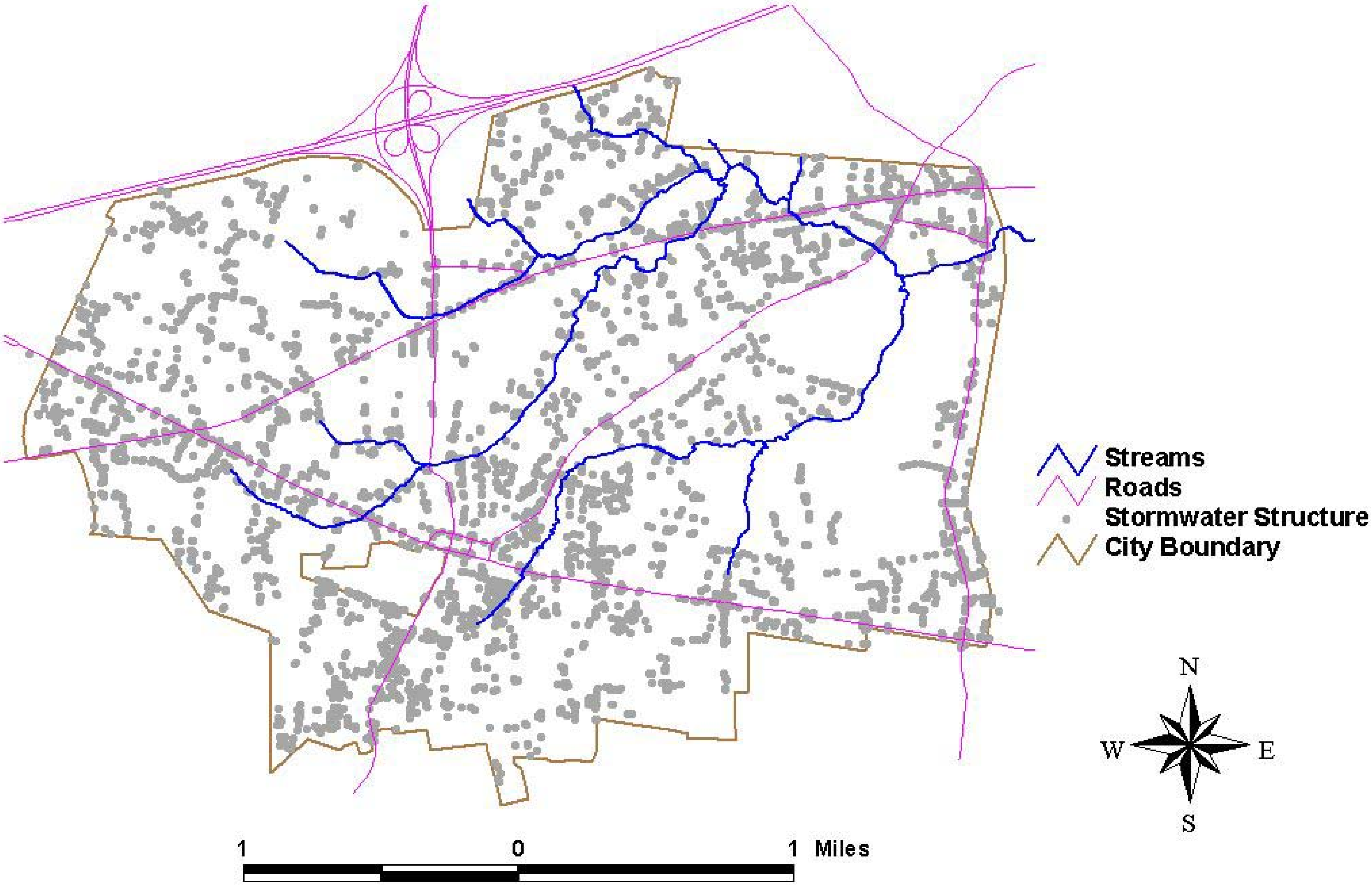
City of Fairfax



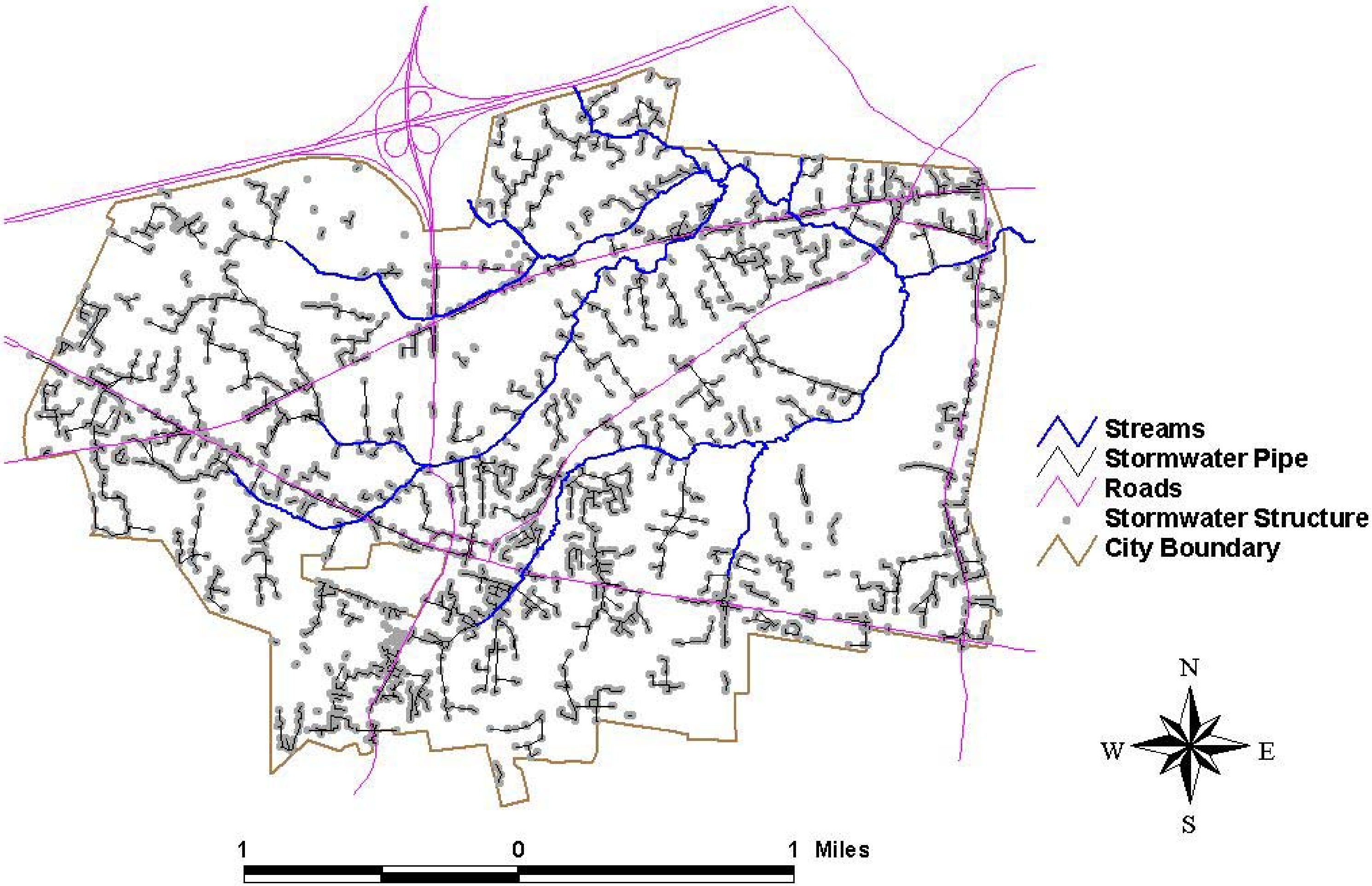
Stormwater Infrastructure Survey

- Objective is to inventory and characterize the city existing stormwater collection and conveyance system.
- Initiated February 2002
- Surveyed 3600 stormwater structures
  - Database
  - GIS layer
  - Connectivity map

Stormwater Structures



Stormwater Connectivity Map



Stream Health Assessment

- Objective is to assess the <u>health of the streams</u> within the boundary of the City of Fairfax.
- Based on the USDA protocols
  - Physical assessment
- Assessment was performed on 72 stream stations.

Stream Physical Conditions

- Physical Stream and Channel Conditions
  - Bank Stability
  - Hydrologic Alteration
  - Riparian Zone
  - Vegetative Protection

Condition	Stream Linear Feet	%
Excellent	300	1
Good	13,730	26
Fair	5,000	9
Poor	34,580	65
Total	**53,610**	**100**

Biological and Habitat Conditions

- Biological and Habitat Conditions:
  - Sediment Deposition
  - Water Appearance
  - Nutrient Enrichment
  - Barriers to Fish Movement
  - Instream Fish Cover
  - Pools
  - Insects/Invertebrate Habitat
  - Canopy Cover
  - Riffle Embeddedness
  - Macroinvertebrates observed

Condition	**Stream Linear Feet**	**%**
Excellent	0	0
Good	0	0
Fair	10,900	20
Poor	42,710	80
Total	**53,610**	**100**

Overall Streams Health

- Based on the:
  - Physical Conditions
  - Biological and Habitat Conditions

Condition	Stream Linear Feet	%
Excellent	0	0
Good	1,350	3
Fair	10,900	20
Poor	41,360	77
Total	**53,610**	**100.0**

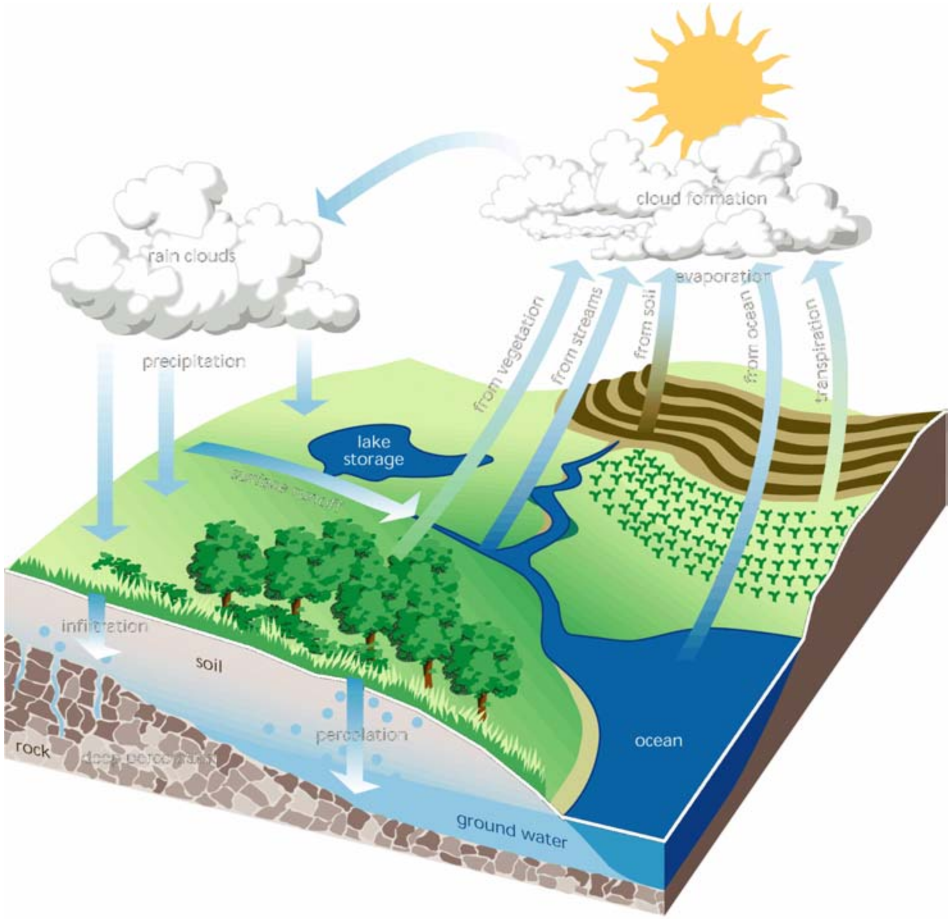
Technical Approach Development

- The objectives are to:
  - Estimate storm volumes and flows.
  - Identify and rank areas in the City with high runoff volumes.
  - Identify potential impacts on the stream reaches.
- Use of hydrologic model to estimate the volume of runoff and peak flow.

Storm Runoff Estimation

- EPA Stormwater Management Model (SWMM)
  - Watershed Model
  - Event or Continuous Simulation
  - Hydrologic Model

Hydrologic Cycle



SWMM

- SWMM Model Modules:
  - Rainfall
  - Runoff
  - Transport
  - Statistics

Rainfall Module

- Reads long time series of precipitation records and generates interface file which is the input to the Runoff block of SWMM.

Runoff Module

- Reads the rainfall data and simulates the quality and quantity of the runoff in a drainage basin.
- The Model incorporates the basin characteristics:
  - Land use
  - Topography
  - Soils types
- The Model reflects processes taking place in the watershed including:
  - Evaporation
  - Infiltration
  - Surface storage

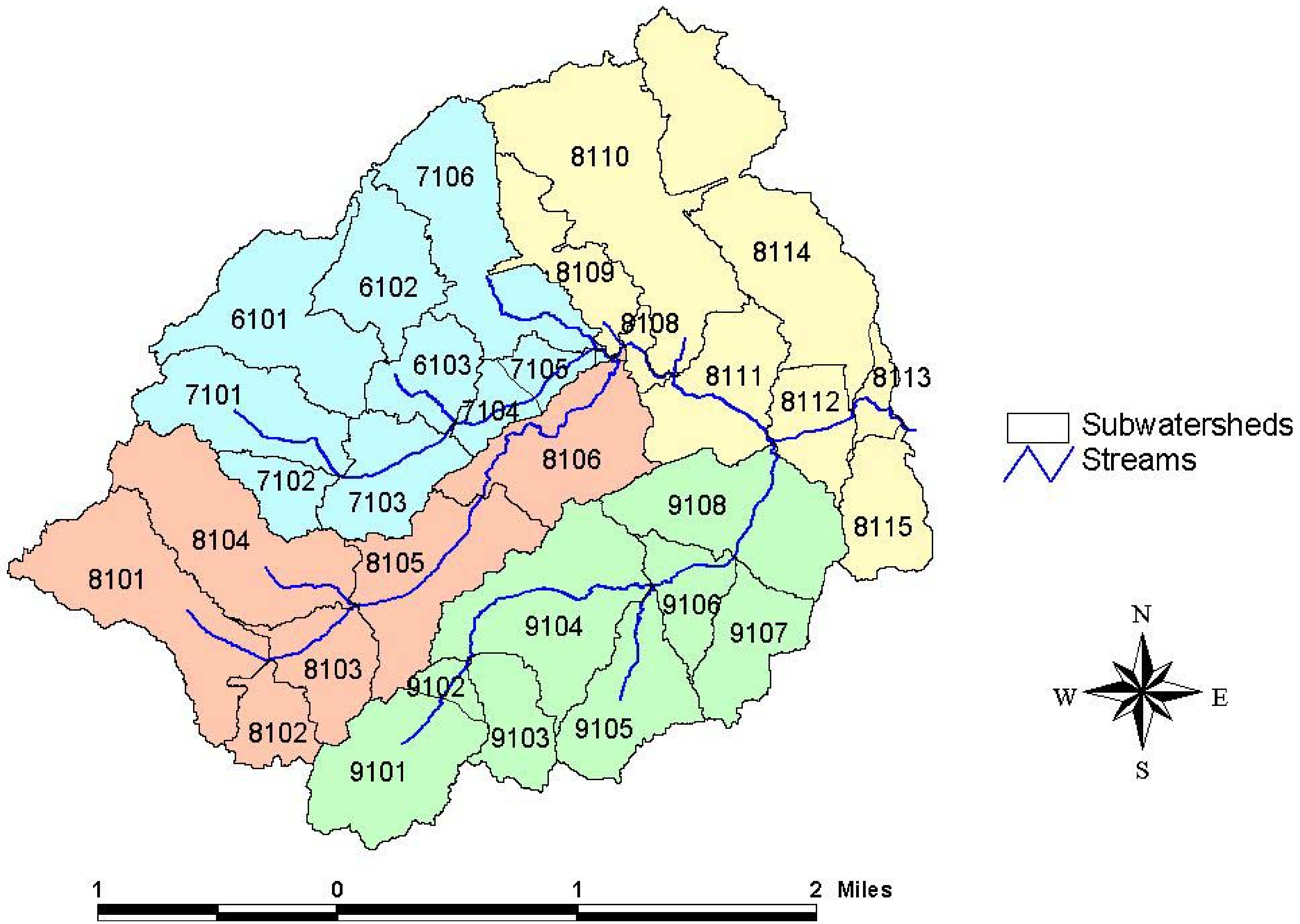
Transport Module

- Reads the runoff generated by the Runoff Module and routs stormwater through the system.
- The model incorporates the stream channels characteristics:
  - Slopes
  - Length
  - Cross sectional areas

Model Set Up

- Watershed delineation
- Watershed physical characteristics
- Stream physical characteristics
- Stream flow for calibration

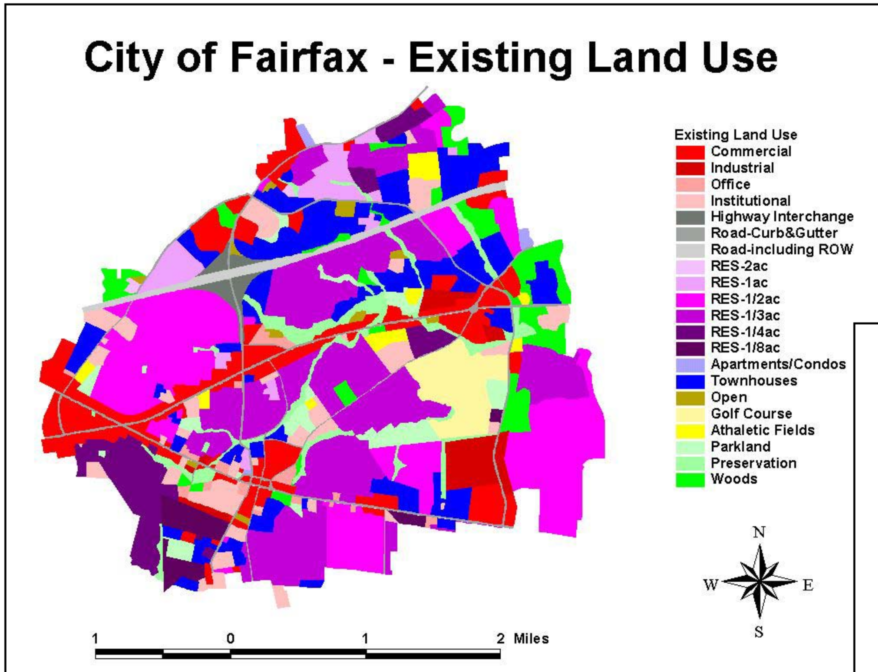
Model Subwatersheds

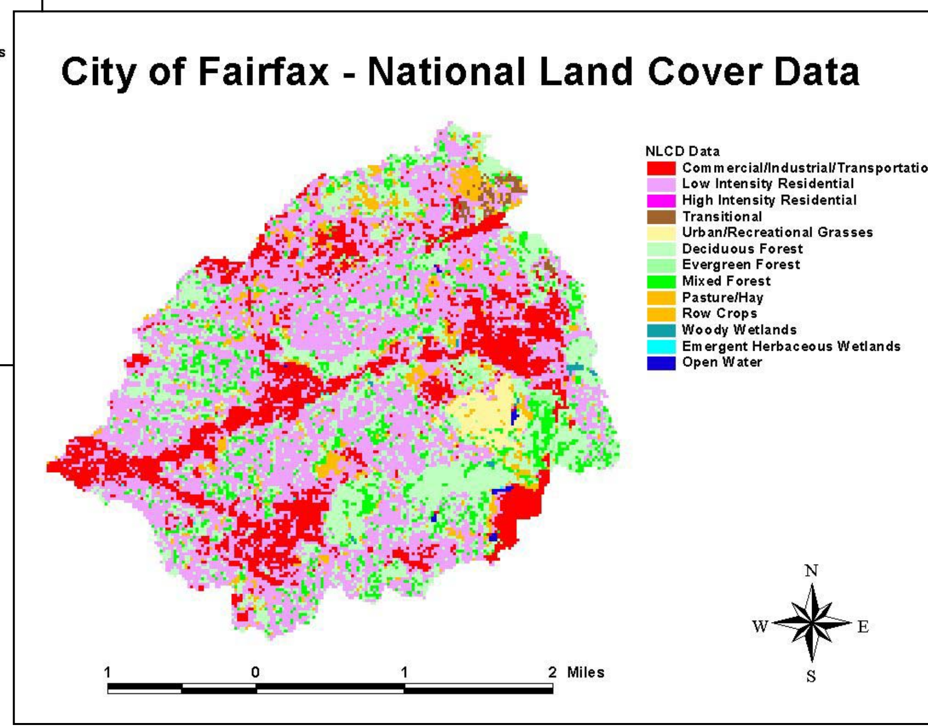


Physical Characteristics of the Watershed

- For each subwatershed:
  - Area
  - Slope
  - Length
  - Width
  - Soil hydrologic group distribution
  - Infiltration
  - Percent imperviousness

Land Use Data

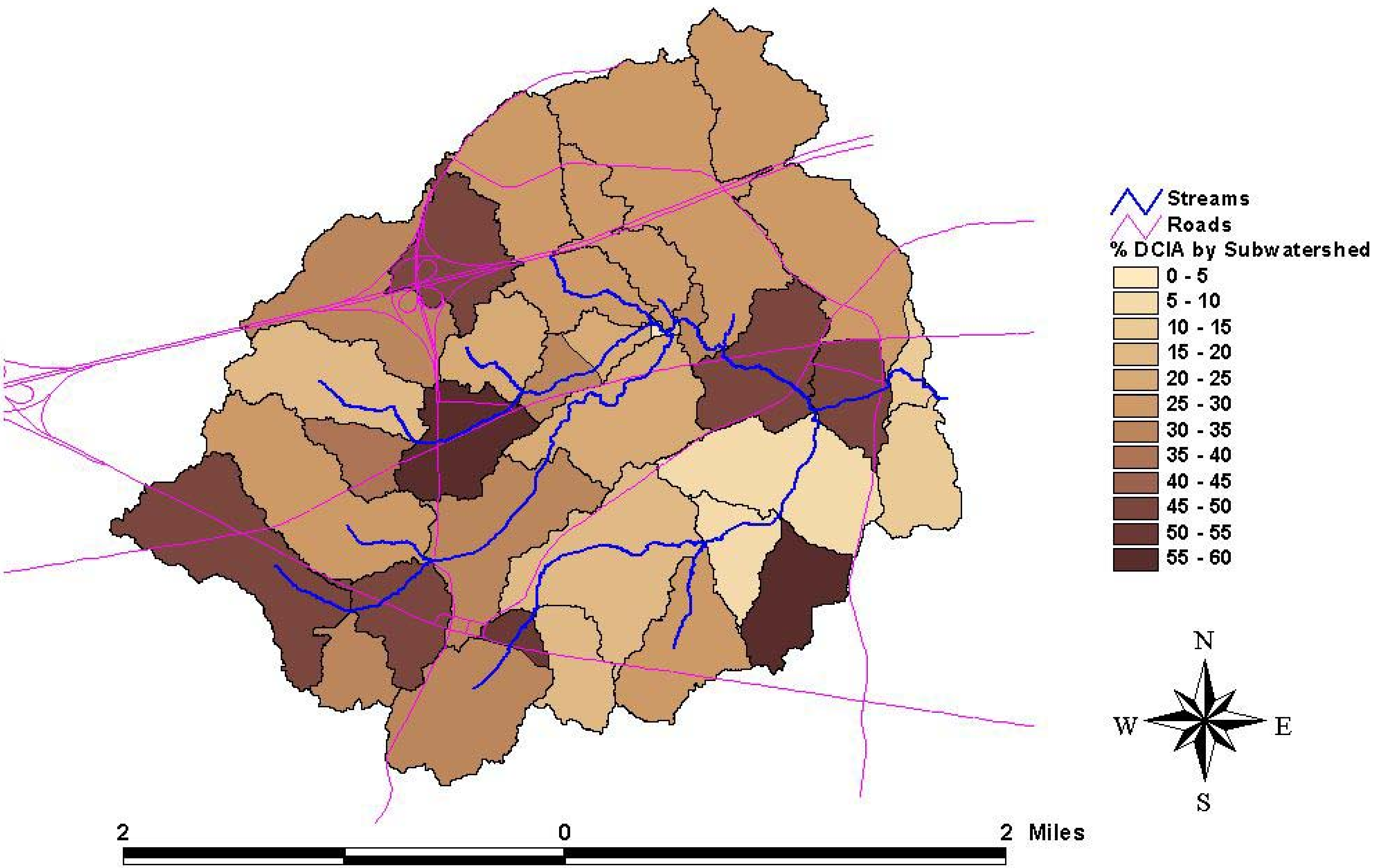




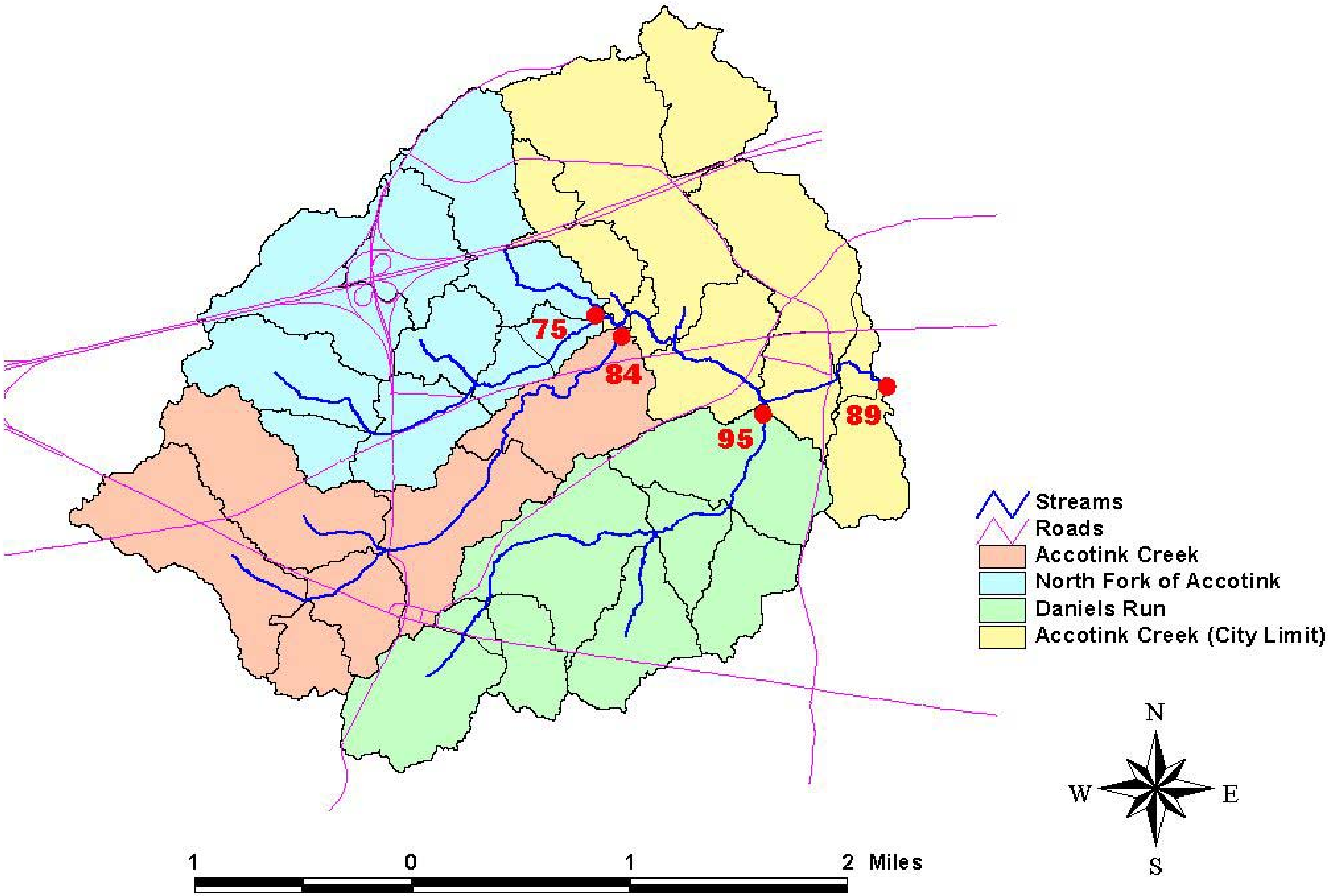
Imperviousness

Subwatershed id	Imperviousness %		
	NLCD data	City of Fairfax data	Average
6101	19.7	44.9	32.3
6102	27.5	69.8	48.6
6103	23.4	24.8	24.1
7101	11.9	23.4	17.6
7102	32.6	38.8	35.7
7103	45.9	66.2	56.0
7104	27.9	36.8	32.4
7105	17.4	24.9	21.2
7106	22.3	37.6	30.0
7107	4.0	1.0	2.5
8101	38.2	54.4	46.3
8102	22.4	46.9	34.7
8103	41.8	56.2	49.0
8104	22.0	32.0	27.0
8105	26.7	38.4	32.5
8106	19.5	29.0	24.2
8107	34.0	1.0	17.5
8108	23.4	39.1	31.3
8109	19.3	34.8	27.0
8110	19.9	31.1	25.5
8111	40.8	56.8	48.8
8112	39.7	53.9	46.8
8113	16.7	9.4	13.0
8114	22.0	34.9	28.5
8115	6.8	17.1	12.0
9101	23.5	42.6	33.1
9102	43.6	61.5	52.5
9103	8.3	23.9	16.1
9104	13.7	26.0	19.9
9105	16.4	36.3	26.4
9106	5.7	11.8	8.8
9107	52.0	60.5	56.3
9108	7.6	10.7	9.2

Model Impervious Percentages (DCIA)

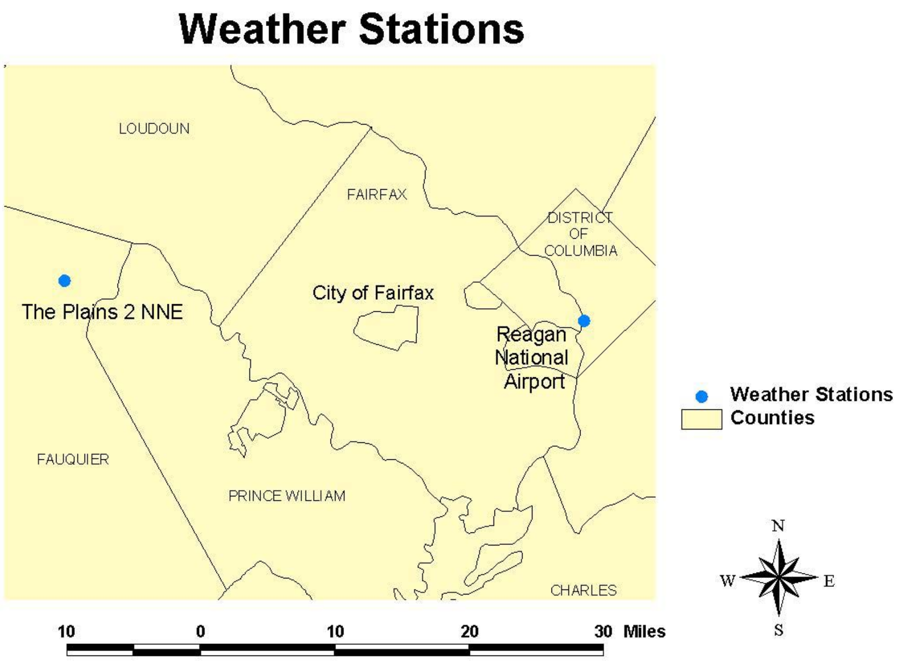


Model Subwatershed Drainage Nodes



Rainfall Gages

- Stations Considered:
  - National Airport
  - The Plains
- Based on proximity to Fairfax and the period of record the National Airport station was selected.



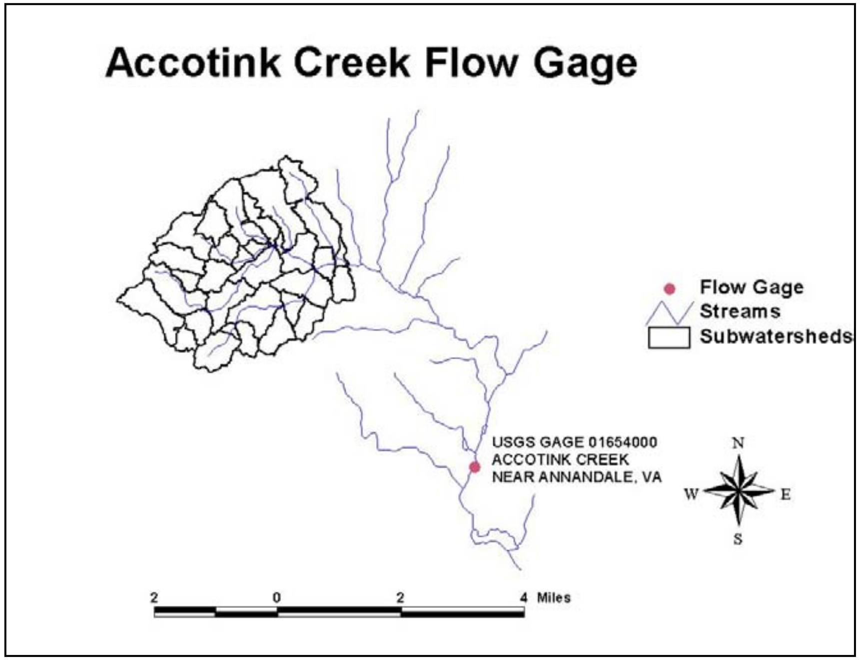
Rainfall Data Summary

National Airport:

- Period of record: 1948 to 2000
- Precipitation conditions for the 52 years:
  - Lowest: 26 inches in 1965
  - Highest: 52 inches in 1983
  - Average precipitation is 38.9 inches

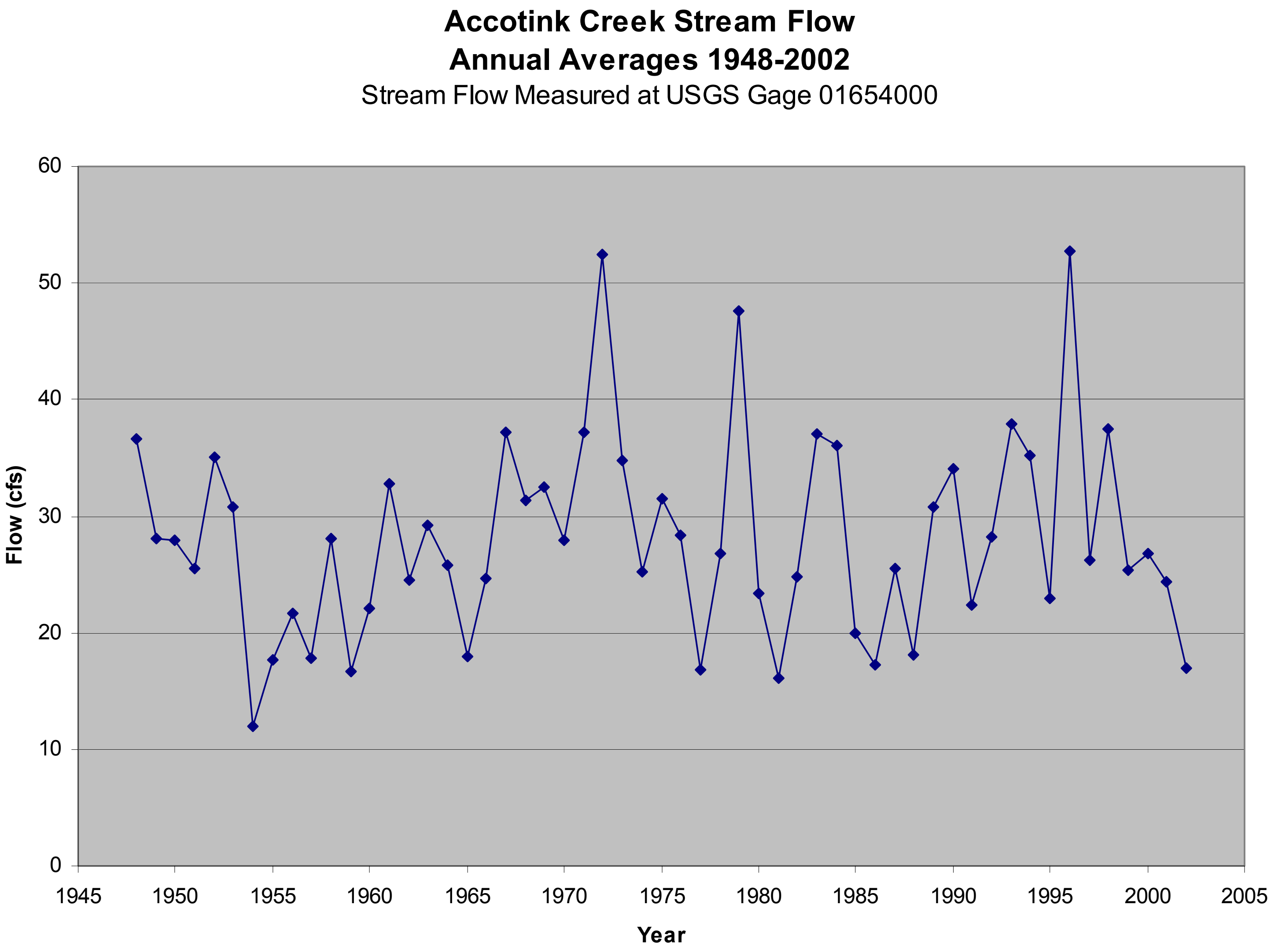
Stream Flow Data

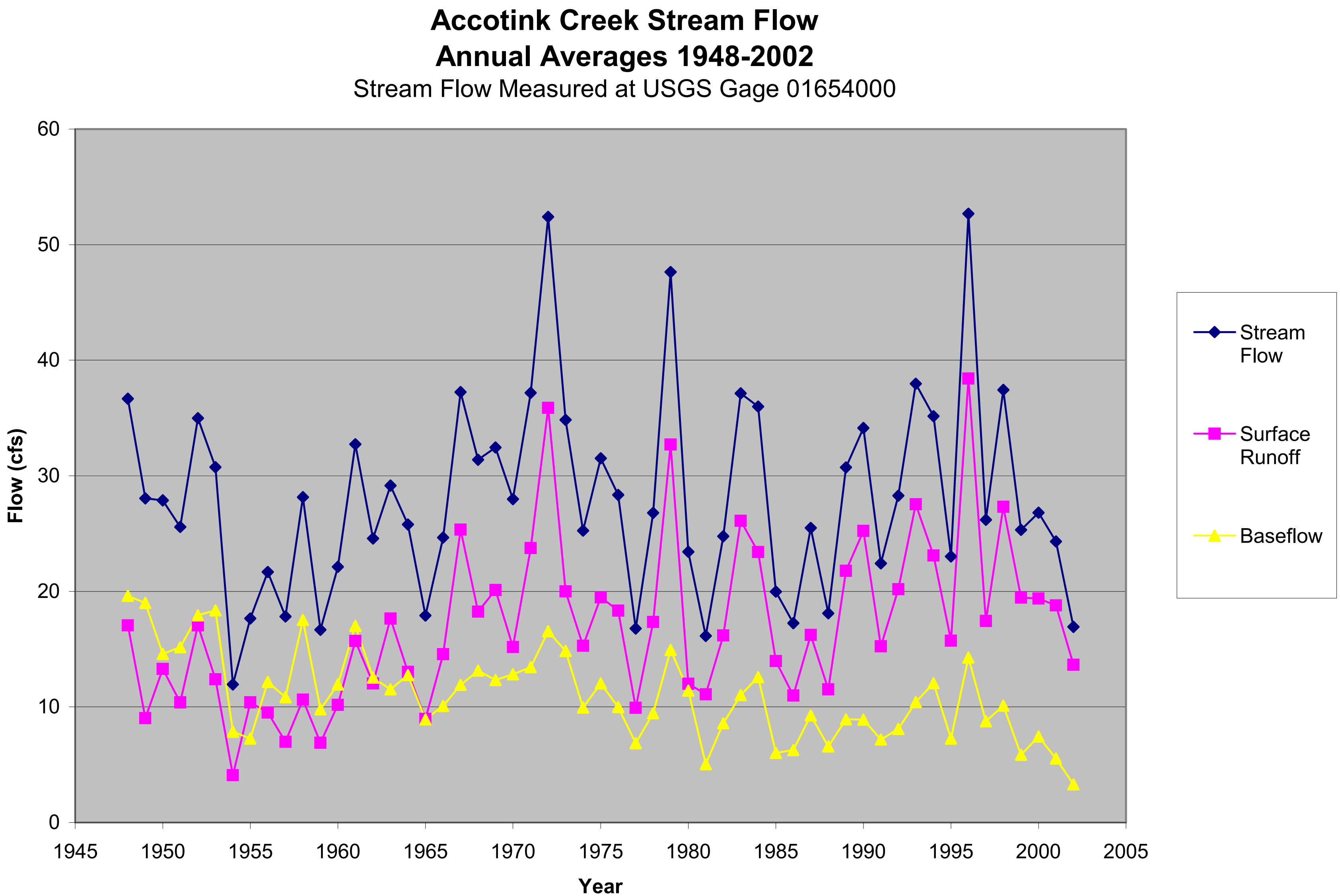
- USGS Gage number 01654000
- Period of record from 1948 to 2002
- Area contributing the gage is 23.4 square miles
- City of Fairfax is about 1/3 of the drainage area
- Similar land uses



Comparison of Land Uses

Land Use Category	% of Watershed Area	
	City of Fairfax	Accotink Watershed
Open Water	0.2	0.2
Low Intensity Residential	43.1	38.2
High Intensity Residential	0.0	0.0
Commercial/Industrial/Transportation	17.5	15.6
Transitional	0.6	1.3
Deciduous Forest	21.5	26.1
Evergreen Forest	1.8	2.4
Mixed Forest	7.9	9.7
Pasture/Hay	5.3	4.5
Row Crops	0.0	0.0
Urban/Recreational Grasses	1.8	0.6
Woody Wetlands	0.2	1.3
Emergent Herbaceous Wetlands	0.0	0.1
	100	100


Accotink Creek Stream Flow
Annual Averages 1948-2002
Stream Flow Measured at USGS Gage 01654000
Flow (cfs)
Year
0
10
20
30
40
50
60
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005



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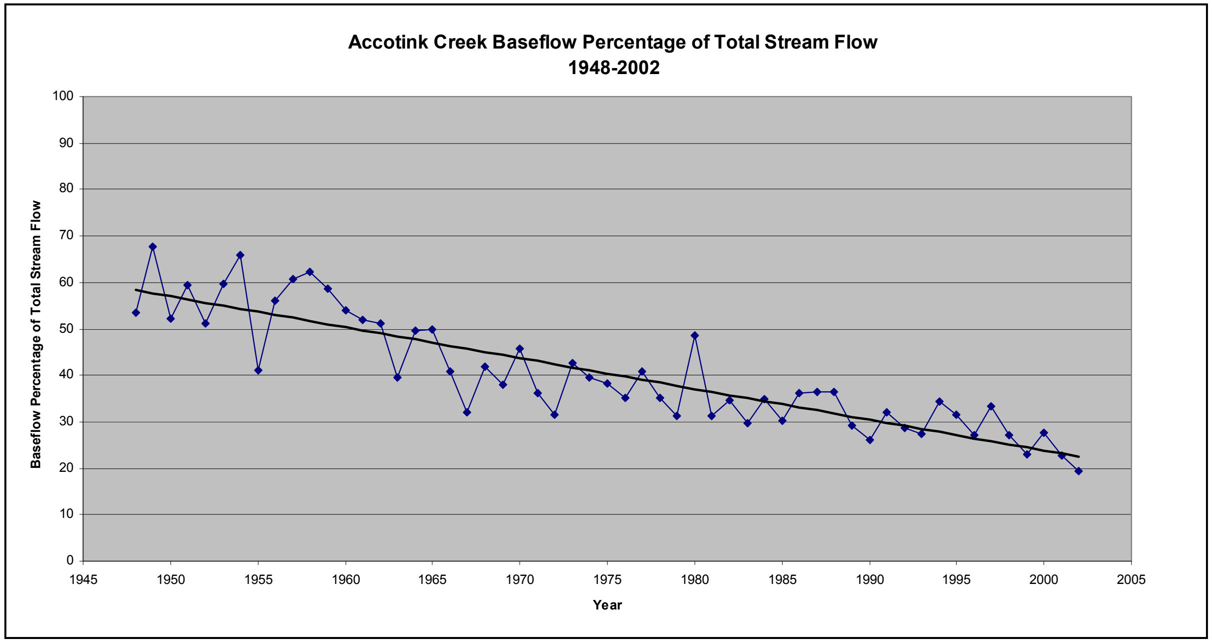
1990
1995
2000
2005
Stream Flow
Surface Runoff
Baseflow

Baseflow Contribution to Stream Flow

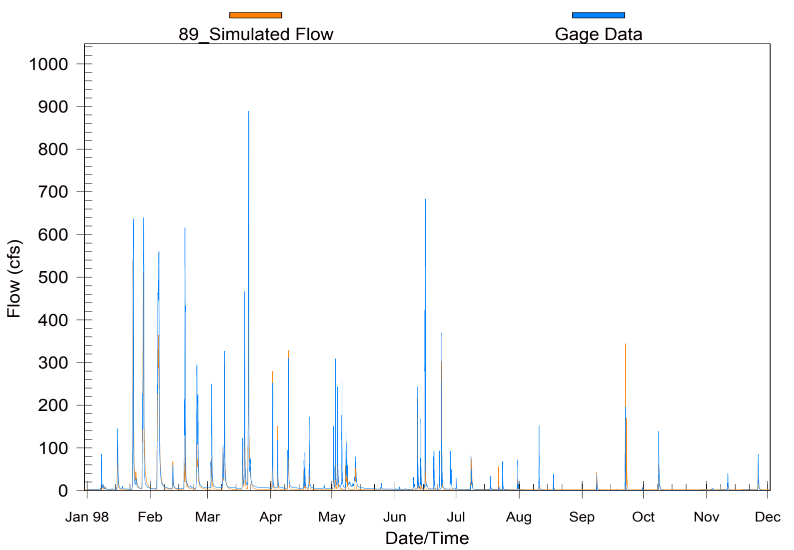
- As a consequence of build up and urbanization the baseflow contribution to the stream flow has been steadily decreasing since 1948.
- The percent contribution of baseflow has decreased from about 58% to 22%.
- The percent contribution of Storm flow increased.

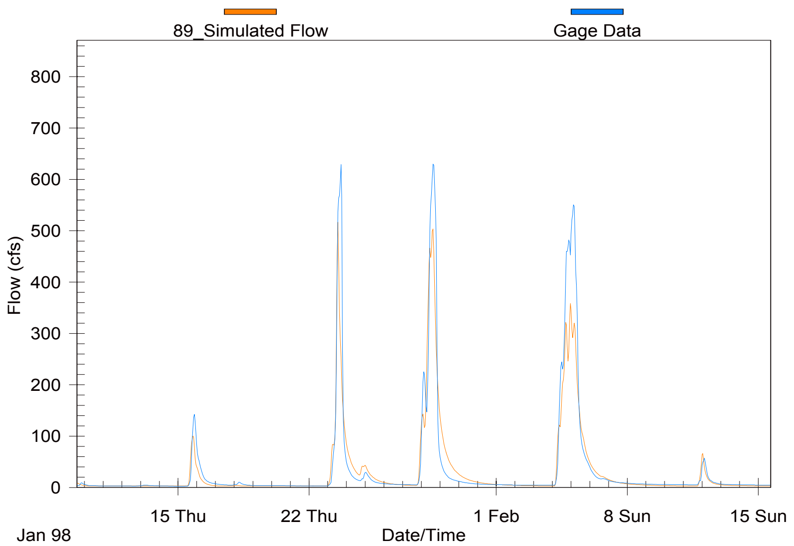


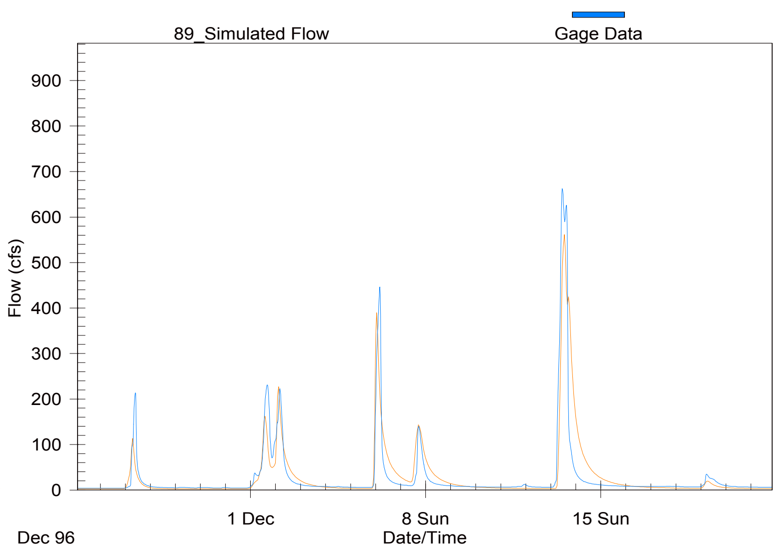
Model Calibration

- Model was setup and calibrated based on the following:
  - 1998 land use data
    - Average percent impervious (City and NCLD Land use data)
  - 1998 rainfall data from National Airport
  - 1998 Stream flow data from USGS gage

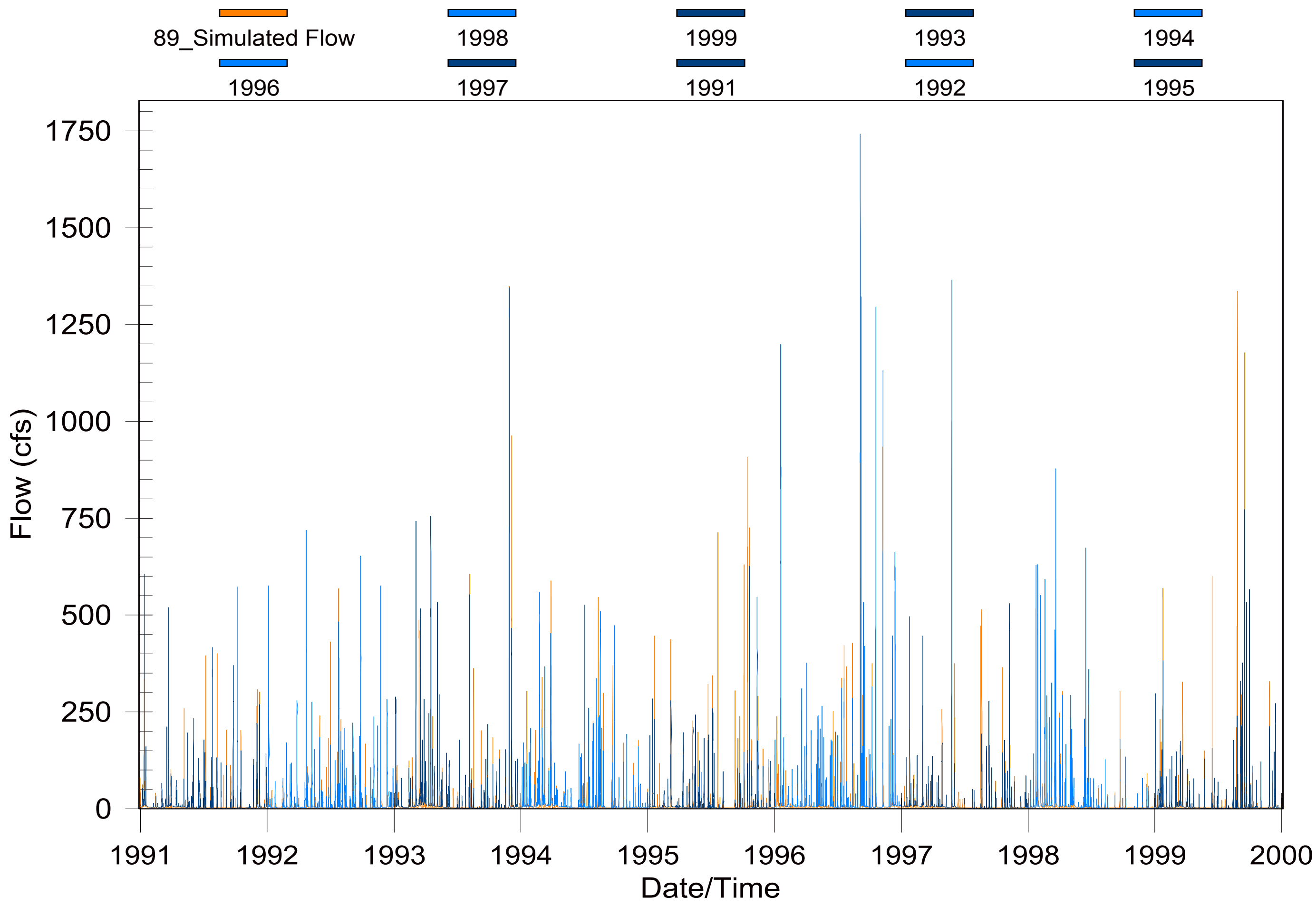
Calibration Results







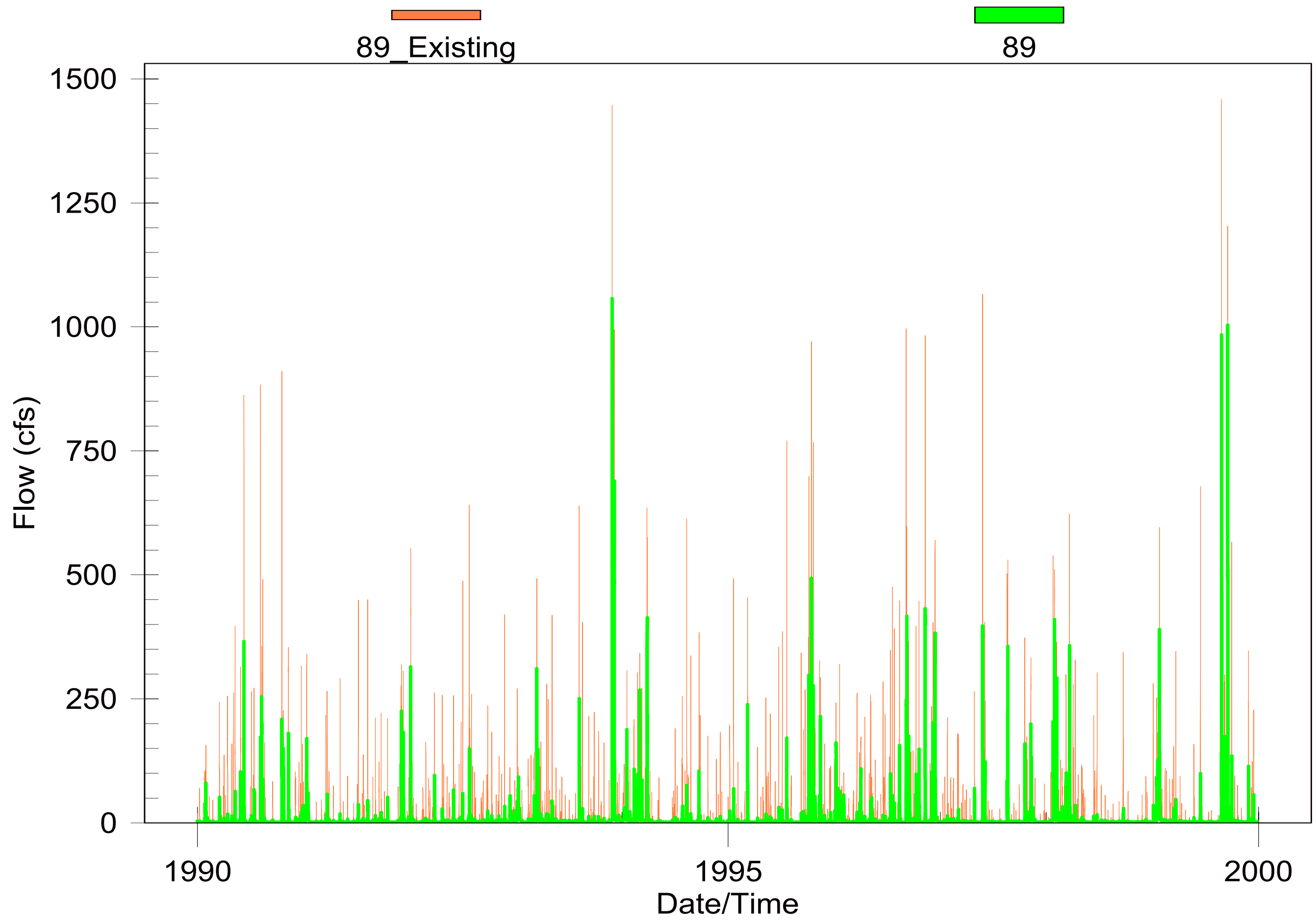
Simulated Vs Gage Flow Data



Model Scenarios Runs

- Performed for 1990 - 2000
- Existing condition- 1998 land use condition
- Forested condition
- Impervious reductions:
  - 10 percent
  - 25 percent
  - 50 Percent
  - 75 Percent

Existing and Forested Storm Flows



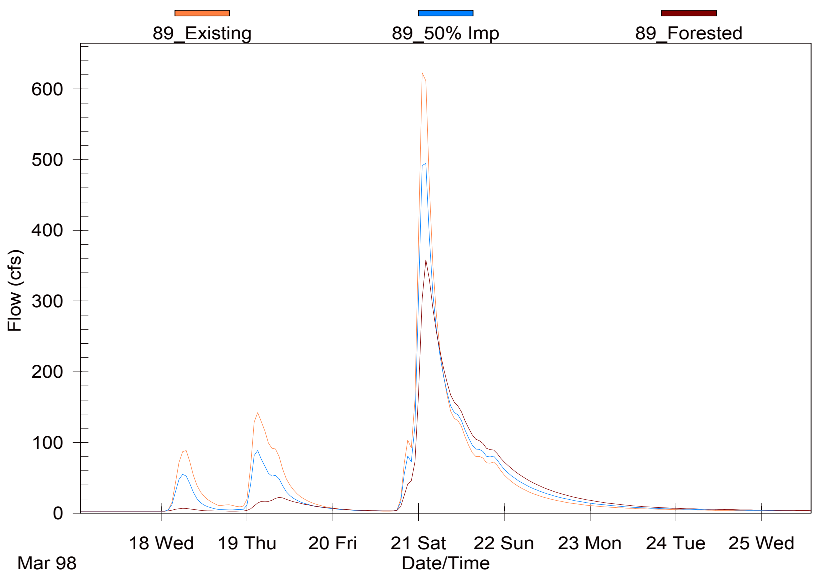
Model Results (1/2)

Node	Stream Name	Scenario	Maximum Flow (cfs)	Total Flow (ft^3)
89	Accotink Creek (@ City Limit)	Existing	1459	3.146E+09
		10% Reduction	1430	3.053E+09
		25% Reduction	1382	2.907E+09
		50% Reduction	1289	2.655E+09
		75% Reduction	1177	2.385E+09
		Forested	1058	2.123E+09
95	Daniels Run	Existing	494	7.099E+08
		10% Reduction	479	6.901E+08
		25% Reduction	454	6.592E+08
		50% Reduction	408	6.067E+08
		75% Reduction	355	5.518E+08
		Forested	320	5.012E+08
84	Accotink Creek (@ North Fork)	Existing	516	7.599E+08
		10% Reduction	498	7.346E+08
		25% Reduction	469	6.942E+08
		50% Reduction	413	6.256E+08
		75% Reduction	341	5.519E+08
		Forested	294	4.802E+08
75	North Fork Accotin	Existing	474	8.361E+08
		10% Reduction	461	8.120E+08
		25% Reduction	453	7.734E+08
		50% Reduction	414	7.059E+08
		75% Reduction	348	6.343E+08
		Forested	287	5.638E+08

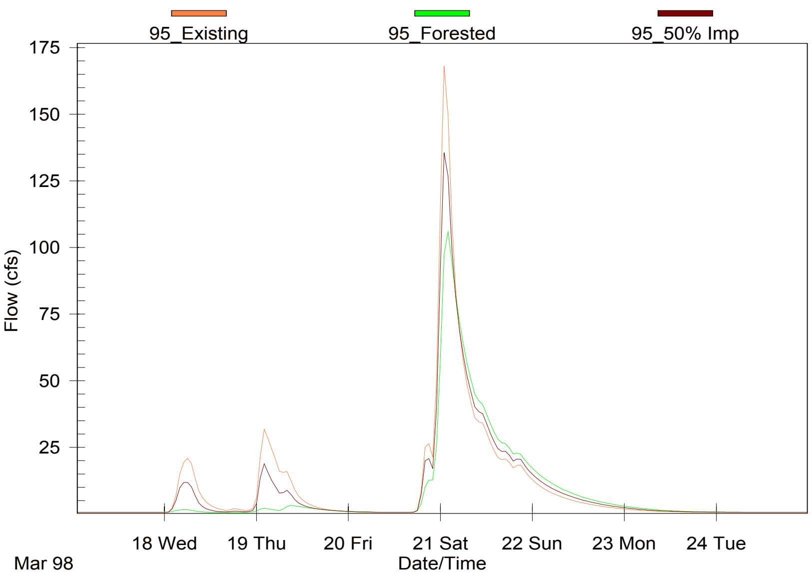
Model Results (2/2)

Node	Stream Name	Scenario	Ratio Relative to Forested Max. Flow	Ratio Relative to Forested Storm Flow	% Increase Storm Tot. Flow Relative to Forested
89	Accotink Creek (@ City Limit)	Existing	1.4	1.8	79.8
		10% Reduction	1.4	1.7	72.5
		25% Reduction	1.3	1.6	61.1
		50% Reduction	1.2	1.4	41.5
		75% Reduction	1.1	1.2	20.4
		Forested	1.0	1.0	0.0
95	Daniels Run	Existing	1.5	1.7	69.9
		10% Reduction	1.5	1.6	63.3
		25% Reduction	1.4	1.5	52.9
		50% Reduction	1.3	1.4	35.4
		75% Reduction	1.1	1.2	17.0
		Forested	1.0	1.0	0.0
84	Accotink Creek (@ North Fork)	Existing	1.8	2.0	98.1
		10% Reduction	1.7	1.9	89.3
		25% Reduction	1.6	1.8	75.1
		50% Reduction	1.4	1.5	51.0
		75% Reduction	1.2	1.3	25.2
		Forested	1.0	1.0	0.0
75	North Fork Accotin	Existing	1.7	1.8	76.6
		10% Reduction	1.6	1.7	69.8
		25% Reduction	1.6	1.6	59.0
		50% Reduction	1.4	1.4	40.0
		75% Reduction	1.2	1.2	19.8
		Forested	1.0	1.0	0.0

Comparison of Storm Volume and Peaks for Different Scenarios



Accotink Creek



Daniels Run

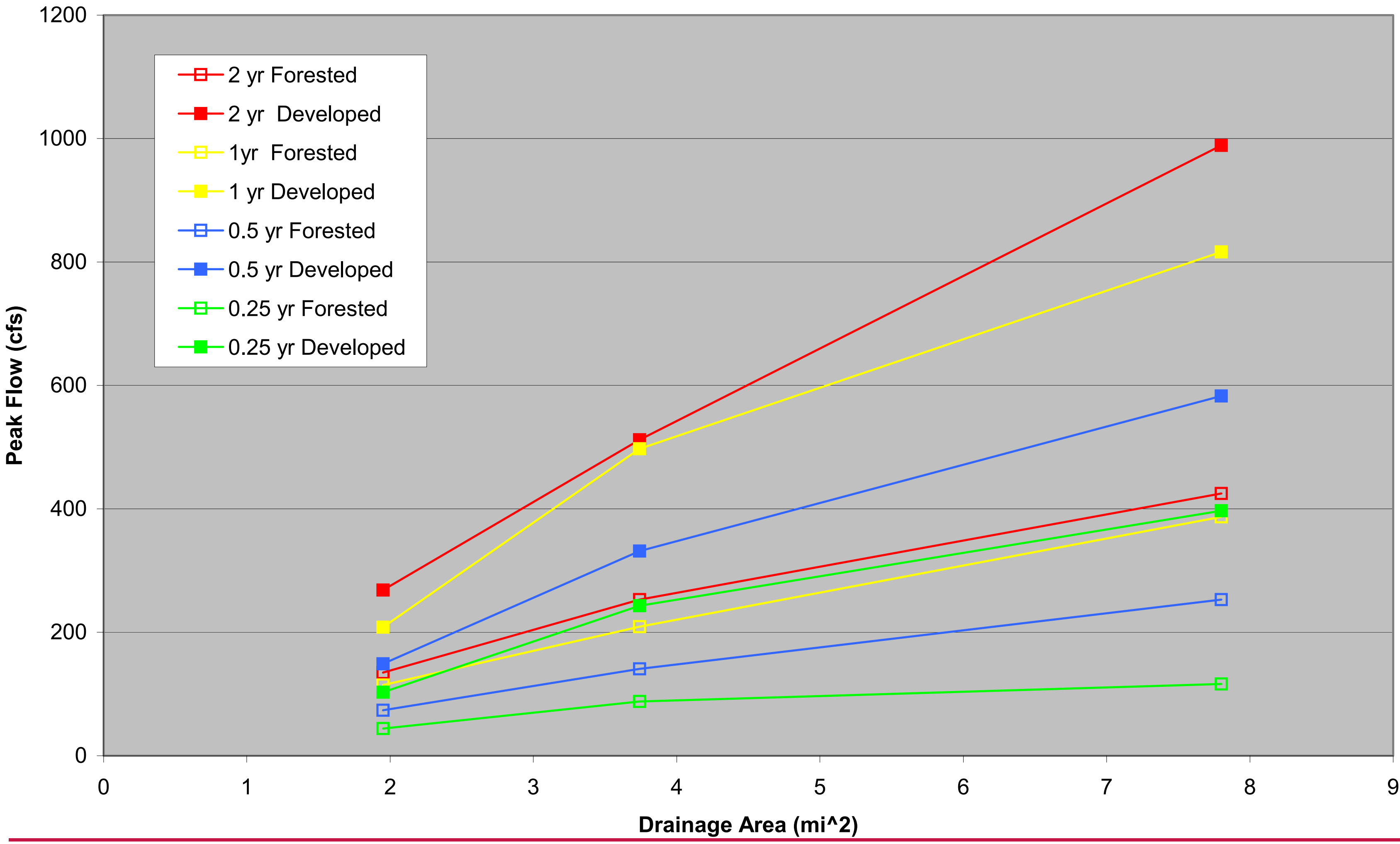
Frequency of Exceedance of Forested Peak Flow

Node	Exceedance of Forested Peak Flow No.	%
95	2	0.4
841	16	3.1
89	54	10.4

Node	Exceedance of Forested Avg Peak Flow No.	%
95	179	35
841	349	67
89	422	81

Total number of events is 518
Forested condition 1-year peak flow is 380 cfs
Forested condition 10-year average peak flow is 37 cfs

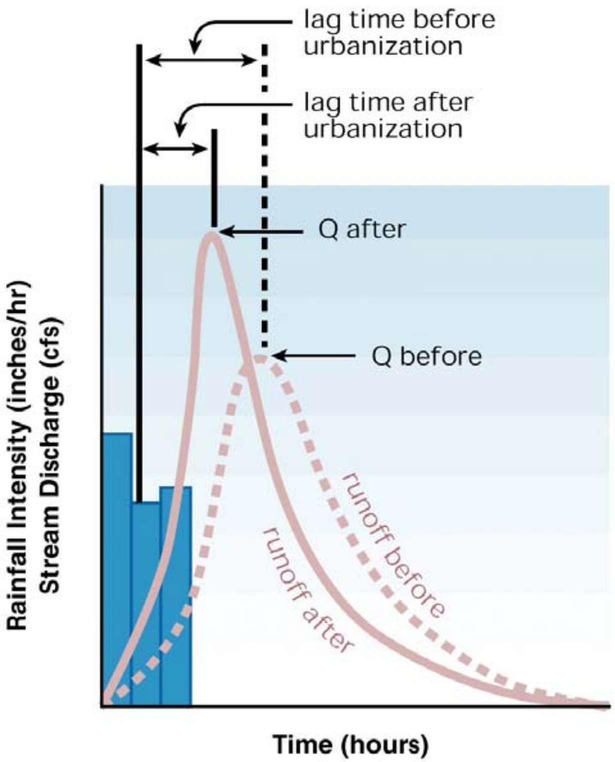
Comparison of Peak Flows for Various Return Periods
Forested vs. Developed Conditions



Fundamental Questions

1. Is it possible to achieve the required stormwater volume reduction?

2. Can reducing the volume of stormwater runoff eliminate Further stream degradation?



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Stormwater Management Perspectives

- Paradigm 1: Run it in Ditches (Early days)
- Paradigm 2: Run it in Pipes (Turn of century)
- Paradigm 3: Run it in Stormwater Pipes (World War II)
- Paradigm 4: Keep it from Stormwater Pipes (Early 1970s)
- Paradigm 5: Well, Just do not Cause Flooding (Mid to late 1970s)

- Paradigm 6: Do not Pollute (Phase 1 Stormwater Regulation-1987)
- Paradigm 7: It is the Ecology (Stream Health and Biocriteria- 1990s)
- Paradigm 8: Water is water is Watershed (1990s Holistic approach)
- Paradigm 9: Green and Bear it (Green Revolution)

Source: Thomas Debo and Andrew Reese, Municipal Stormwater Management

Constraints and Issues

- Constraints:
  - City is already build out
  - Retrofitting
  - Space limitation
  - Stormwater regulations
  - Cost consideration
- Issues:
  - Overall stream health is poor
  - Flooding

Dealing with Stormwater

- Reduce the volume
  - Reducing imperviousness
    - LID
      - City wide implementation
      - Reinforcement is an issue

- Control the volume of runoff
  - Structural controls
    - Retrofit existing sites
    - On site storage
    - Regional detention ponds

- Flooding Issue
  - Improve stormwater conveyance
    - Stormwater sewer network
    - Streams

Next Steps

- Stakeholders
  - Input and feedback
  - Task Group
- Develop alternatives
- Present a draft plan
- Finalize plan